

AFTERSHOCK OBSERVATION OF THE 2014 SOUTH NAPA EARTHQUAKE AND SHALLOW S-WAVE VELOCITY STRUCTURE OBTAINED BY SURFACE WAVE METHODS

K. Hayashi¹, C. Roughley², and M. Craig²

1. Geometrics Inc., San Jose, CA

2. Dept. Earth & Environmental Sciences, California State University East Bay

In response to the 2014 M6.0 Napa earthquake, we recorded aftershocks and conducted S-wave velocity (VS) surveys using active and passive surface wave methods at four sites in Napa. Portable accelerometers were deployed at three locations for aftershock observation on the day after the mainshock; on the east side of Napa Valley (CSUEB-3), the west side (CSUEB-2), and at Stone Bridge School (CSUEB-1 SBS), which is located directly on the line of surface rupture. The accelerometers recorded continuous data for two weeks. At least 550 aftershocks with magnitudes between -0.6 and 3.9 were recorded during the week following the mainshock.

Surface wave surveys were conducted at each of the three aftershock observation sites and also at Napa Valley College. Surface wave surveys were conducted using the active source MASW (multichannel analysis of surface waves) method and two passive methods; a linear microtremor array method (Linear-MAM) and a two-station spatial autocorrelation method (2ST-SPAC). A 24-channel seismograph with 4.5 Hz geophones was used for MASW and Linear-MAM surveys, and two 3-component portable broadband accelerometers were used for 2ST-SPAC surveys. In 2ST-SPAC surveying, one instrument was established at a fixed location and used to record ambient noise for the duration of the survey. A second instrument was placed at a series of different locations, at distances from the fixed station ranging from 5 to 2800 m. At each measurement location, ambient noise was recorded for intervals ranging from 5 to 40 minutes using a 10 ms sample rate, for a total of several hours of data acquisition per site.

Dispersion curves from the one active and two passive methods were combined and phase velocities were obtained to a minimum frequency of 0.3 Hz. VS profiles were determined by joint inversion of dispersion curves and horizontal to vertical spectral ratio (HVSr) curves. VS profiles obtained by the surface wave surveys are generally consistent with site-specific differences in amplification and S-P times observed in aftershocks.

VS profiles at most sites were determined to a depth to 2000 m through the use of a 2ST-SPAC survey, which includes relatively large offsets and recording durations. Depth to bedrock with VS higher than 3000 m/s appears to be at least 2000 m at three of the sites. The upper 100 m of VS profiles at all four sites may be represented with three layers; a near-surface layer with VS less than 250 m/s, an intermediate layer with VS 250 to 450 m/s, and a shallow bedrock with VS more than 450 m/s. Thickness of the near-surface layer ranges from less than 5 m to 15m. Depth to the shallow bedrock ranges from ~ 30 to 50 m. AVS 30 ranges from ~ 235 m/s to 300 m/s.